INTERFERENCE-AVOIDANCE ORIENTED CARRIER REUSE OF DEVICE-TO-DEVICE (D2D) COMMUNICATION IN CELLULAR NETWORKS

BACKGROUND

[0001] 1. Field

[0002] Embodiments of the invention generally relate to wireless communications networks, such as, but not limited to, the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (UTRAN) and/or Long Term Evolution (LTE) Evolved UTRAN (E-UTRAN) or LTE-Advanced (LTE-A), and to device-to-device (D2D) links that enable direct communication of data between user equipment.

[0003] 2. Description of the Related Art

[0004] Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (UTRAN) refers to a communications network including base stations, or Node Bs, and for example radio network controllers (RNC). UTRAN allows for connectivity between the user equipment (UE) and the core network. The RNC provides control functionalities for one or more Node Bs. The RNC and its corresponding Node Bs are called the Radio Network Subsystem (RNS). In case of E-UTRAN (Evolved UTRAN) no RNC exists and most of the RNC functionalities are contained in the evolved Node B (eNB).

[0005] Long Term Evolution (LTE) or E-UTRAN refers to enhancements of the UMTS through improved efficiency and services, lower costs, and use of new spectrum opportunities. In particular, LTE is a 3GPP technical standard that provides for uplink peak rates of at least 50 megabits per second (Mbps) and downlink peak rates of at least 100 Mbps. LTE supports scalable carrier bandwidths from 20 MHz down to 1.4 MHz and supports both Frequency Division Duplex (FDD) and Time Division Duplex (TDD).

[0006] As mentioned above, LTE is also expected to improve spectral efficiency in 3G networks, allowing carriers to provide more data and voice services over a given bandwidth. Therefore, LTE is designed to fulfill future needs for high-speed data and media transport in addition to high-capacity voice support. Advantages of LTE are, for example, high throughput, low latency, FDD and TDD support in the same platform, an improved end-user experience, and a simple architecture resulting in low operating costs.

[0007] Further releases of 3GPP LTE (e.g., Rel-10, Rel-11) are targeted towards future international mobile telecommunications advanced (IMT-A) systems, referred to herein for convenience simply as LTE-Advanced (LTE-A).

[0008] LTE-A is directed toward extending and optimizing the 3GPP LTE radio access technologies. A goal of LTE-A is to provide significantly enhanced services by means of higher data rates and lower latency with reduced cost. LTE-A will be a more optimized radio system fulfilling the international telecommunication union-radio (ITU-R) requirements for IMT-Advanced while keeping the backward compatibility.

SUMMARY

[0009] One embodiment is directed to a method including obtaining, in a hybrid device-to-device (D2D) and cellular network, related information for interfering cellular user equipment. The method may further include reporting the related information for the interfering cellular user equipment to an evolved node B (eNB), receiving a list of component carriers and competition related information for the component carriers, and selecting at least one proper component carrier from the list of component carriers according to certain rules.

[0010] Another embodiment includes an apparatus which may include at least one processor and at least one memory comprising computer program code. The at least one memory and the computer program code may be configured, with the at least one processor, to cause the apparatus at least to obtain, in a hybrid device-to-device (D2D) and cellular network, related information for interfering cellular user equipment, to report the related information for the interfering cellular user equipment to an evolved node B (eNB), to receive a list of component carriers and competition related information for the component carriers, and to select at least one proper component carrier from the list of component carriers according to certain rules.

[0011] Another embodiment may include a computer program, embodied on a computer readable medium. The computer program may be configured to control a processor to perform a process including obtaining, in a hybrid device-to-device (D2D) and cellular network, related information for interfering cellular user equipment. The process may further include reporting the related information for the interfering cellular user equipment to an evolved node B (eNB), receiving a list of component carriers and competition related information for the component carriers, and selecting at least one proper component carrier from the list of component carriers according to certain rules.

[0012] Another embodiment may include an apparatus comprising means for obtaining, in a hybrid device-to-device (D2D) and cellular network, related information for interfering cellular user equipment. The apparatus may further include means for reporting the related information for the interfering cellular user equipment to an evolved node B (eNB), means for receiving a list of component carriers and competition related information for the component carriers, and means for selecting at least one proper component carrier from the list of component carriers according to certain rules.

[0013] Another embodiment is directed to a method including receiving, from a device-to-device (D2D) user equipment, related information for interfering cellular user equipment in a hybrid network. The method may further include determining, by an evolved node B (eNB), reusable component carriers for the D2D user equipment to utilize, and sending a list of the reusable component carriers and competition related information for the reusable component carriers to the D2D user equipment.

[0014] Another embodiment includes an apparatus which may include at least one processor and at least one memory comprising computer program code. The at least one memory and the computer program code may be configured, with the at least one processor, to cause the apparatus at least to receive, from a device-to-device (D2D) user equipment, related information for interfering cellular user equipment in a hybrid network, to determine re-usable component carriers for the D2D user equipment to utilize, and to send a list of the reusable component carriers and competition related information for the reusable component carriers to the D2D user equipment.

[0015] Another embodiment may include a computer program, embodied on a computer readable medium. The computer program may be configured to control a processor to